

DETAILED ACTION

Response to Arguments

1. Applicant's Arguments, filed 1/14/2010 have been fully considered but are not persuasive.

Applicant argues that a request for a block of memory, as disclosed in Martin, does not indicated that a change in ownership state of the block of memory has occurred. The examiner disagrees. However, in order properly address applicant's remark, the examiner has clarified the rejection of this particular limitation.

Martin et al. discloses providing an ownership update message corresponding to a block of data to at least one of a plurality of owner predictors in response to a change in an ownership state of the block of data; wherein a cache coherency message requesting a block of data is received by each processor unit 12, each processor unit evaluates if it has the requested block of data in their cache memory, depending on the type of request, each processor unit changes its ownership status for that block of data and provides the requested block to the requestor (thus representing the change in an ownership state of the block of data as claimed). In providing the requested block, the processor unit is updating the ownership status of the block since the requestor may acquire ownership or shared status of the block (see par. 0060) and the status is updated in the directory (par. 0061) where the directory indicates the status of blocks of data (par. 0046). Therefore, the message that provides the requested block of data to the requestor represents the ownership update message.

Applicant further argues that it is well known that some memory requests can be refused and because of this, the request of Martin et al. cannot represent the claimed ownership update message. However, even if some requests may be refused, Martin discloses the occurrence of requests that are not refused and result in the ownership update message as claimed. Therefore, the teachings of Martin et al. apply to the claimed subject matter.

Applicant argues that in the rejection of claim 1, the Office Action contends that predictor 98 corresponds to the given owner predictor claimed; however, the predictor of Martin does not teach providing an ownership update message and comprising a second component that stores ownership update messages provided from the owner predictor control.

The examiner disagrees.

The examiner would like to point out that the claim language calls for an owner predictor control. Since predictor 98 is part of cache controller 26, the claimed owner predictor control is represented by the cache controller. Since the predictor 98 of Martin makes predictions by **storing** information about mispredictions of the same or spatially adjacent blocks of data, mispredictions of the same static load or store instructions, or input from software (see par. 0071), it is clear that the predictor 98, and thus cache controller 26, of Martin must comprise a storage component to store the mispredictions and/or input from software as disclosed that are needed in order to formulate predictions. Additionally, the ownership update message claimed is provided by a

responding processor unit 12 (see par. 0060, in providing the requested block to the requestor, the processor unit is updating the ownership status of the block since the requestor may acquire ownership or shared status of the block) wherein the responding processor unit must evaluate the presence of the requested block in its cache and update the block's ownership status in its cache, thus involving the functions of the cache controller 26.

Regarding Claim 12, Applicant argues that Martin does not teach selecting between accessing a first component or a second component based on the frequency in which ownership messages associated with a block of data have been received from an owner predictor control. The examiner disagrees.

Regarding Claim 12, Martin discloses the system of claim 1, wherein the processor employs the given owner predictor to determine a predicted owner for a given block of data (predictor 98, par. 0071), the given owner predictor selecting between accessing the first component and the second component according to the frequency in which ownership update messages associated with the block of data have been received from the owner predictor control (an utilization signal indicates if the system is operating under a high utilization, thus indicating high data traffic and thus a high frequency of ownership update messages, or low utilization, see par. 0057). By using the utilization signal, the system of Martin switches between a snooping cache coherence protocol and a directory cache coherence protocol. During a snooping protocol, the request is snooped only to selected processors based on a prediction, thus

indicating the use of the claimed first component (see par. 0029). During a directory based protocol, the request is sent to the directory 21 which multicasts the request to appropriate processors indicated by the directory's information (see par. 0051). Depending on the result of the request, the directory must be updated, thus indicating the storage of updated ownership information (par. 0061). Additionally, since the predictor must maintain accurate information about the behavior of spatially adjacent blocks in order to properly make predictions (see par. 0071), the predictor's storage unit must be maintained even when the directory protocol is being followed by storing information about the behavior of the blocks whose ownership was updated using the directory protocol. Otherwise, the predictor may not have accurate information to use in order to formulate its predictions of ownership.

Regarding Claim 39, Applicant argues that Martin does not teach the owner predictor control configured to discontinue providing the ownership update message corresponding to a given block of data based on (i) an available bandwidth in the system, and (ii) a frequency with which the given block of data changes ownership. The examiner disagrees.

Martin discloses the system of claim 1, wherein the owner predictor control is configured to discontinue providing the ownership update message corresponding to a given block of data based on (i) an available bandwidth in the system (communicating messages based on bandwidth, par. 0002), and (ii) a frequency with which the given block of data changes ownership. A utilization signal indicates if the system is operating

under a high utilization, thus indicating high data traffic and thus a high frequency of ownership update messages, or low utilization, see par. 0057. By using the utilization signal, the system of Martin switches between a snooping cache coherence protocol and a directory cache coherence protocol. During a snooping protocol, the request is snooped only to selected processors based on a prediction, thus indicating the use of the predictor control for providing ownership update messages, see par. 0029. If the utilization signal indicates that the snooping protocol must be stopped and the system must use the directory protocol (see par. 0057 wherein a directory mechanism is used when the utilization signal is above a threshold), then this indicates that the predictor control must stop providing the ownership update messages since these messages will be handled by the directory protocol mechanism.

Regarding the rejection of claims 13, 21, 30, and 34, the examiner would like to clarify that in the system of Martin, the owner predictor control (represented by cache controller 26, see par. 0071) broadcasts an update message to respectively owner predictor associate with each of a plurality of processors comprising the multiprocessor network (cache coherence messages are broadcasted over the ordered request network to each of the remaining processor units, see par. 0050).

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

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(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1-8, 10-13, 17-23, and 26-41 are rejected under 35 U.S.C. 103(a) as being unpatentable over Martin et al. (US 2002/0133674 A1)

Regarding Claim 1, Martin et al. discloses a multi-processor system (shown in Figure 1) comprising:

an owner predictor control (par. 0043, cache controller 26 comprising predictor 98 of Fig 8) that provides an ownership update message corresponding to a block of data to at least one of a plurality of owner predictors in response to a change in an ownership state of the block of data (cache coherency message requesting a block of data is received by each processor unit 12, each processor unit evaluates if it has the requested block of data in their cache memory, depending on the type of request, each processor unit changes its ownership status for that block of data and provides the requested block to the requestor, wherein providing the requested block the processor unit is updating the ownership status of the block since the requestor may acquire ownership or shared status of the block, see par. 0060 and the status is updated in the directory, par. 0061. Therefore, the message that provides the requested block of data to the requestor represents the ownership update message), the update message comprising an address tag associated with the block of data and an identification associated with an owner node of the block of data (a response to a request for data, in

the form of providing the requested block to the requestor, must include an identification of the block requested and the node of the requestor); and

wherein a given one of the plurality of owner predictors, associated with a processor (par. 0043, cache controller 26 comprising predictor 98 of Fig 8 which is part of each of the plurality of processor units 12, as shown in Fig. 1), comprises a first component that predicts an owner node of the block of data by observing the pattern of instructions within the processor (function of predictor 98) and a second component that stores ownership update messages provided from the owner predictor control (par. 0071, the predictor 98 which is part of cache controller 26 of Martin makes predictions by **storing** and evaluating information about mispredictions of the same or spatially adjacent blocks of data, mispredictions of the same static load or store instructions, or input from software).

Regarding Claim 2, Martin discloses the system of claim 1, wherein the owner predictor control provides an ownership update message when the block of data at the owner node transitions to one of a modified or exclusive state (multicast due to request, thus the block will be accessed, thus modified or exclusive state, par. 0005).

Regarding Claim 3, Martin discloses the system of claim 1, further comprising a requesting node that provides a first request for the block of data to a home node, the requesting node being operative to provide a second request for the block of data to at least one predicted node in parallel with first request the at least one predicted node

being selected by an associated one of the plurality of owner predictors (multicast to limited number of indicated caches, par. 0006).

Regarding Claim 4, Martin discloses the system wherein the requesting node receives a coherent copy of the block of data from at least one of the home node and the at least one predicted node, the requesting node consuming a first coherent copy of the block of data received (the node owning the block responds directly to requesting node, par. 0005).

Regarding Claim 5, Martin discloses the system of claim 3, wherein a cached copy of the block of data exists at the owner node, the home node issuing a third request for the block of data to the owner node (requests to directory, directory multicast request to a number of selected caches, thus third request, par. 0006).

Regarding Claim 6, Martin discloses the system of claim 5, wherein the system employs a directory-based cache coherency protocol, the home node further comprising a directory that maintains directory state information associated with the block of data, the home node issuing the third request to the owner node based on the directory state information indicating that the owner node has an exclusive cached copy of the block of data (par. 0006).

Regarding Claim 7, Martin discloses the system of claim 5, wherein the owner node provides one of (i) a response to the home node and (ii) a response to the home node and to the requesting node, the owner node providing the response based on a state of the cached copy of the block of data at the owner node (the node owning the block responds directly to requesting node, par. 0005).

Regarding Claim 8, Martin discloses the system of claim 5, wherein the at least one predicted node comprises the owner node, the owner node having an exclusive cached copy of the block of data and providing a data response to the requesting node based on which of the second request and the third request arrives at the owner node first (the node owning the block responds directly to requesting node, par. 0005).

Regarding Claim 10, Martin discloses the system of claim 1, wherein the second component stores the provided update messages according to a first-in-first-out (FIFO) arrangement (prioritizes predictions based on recent interpretations, thus representing the storage of interpretations in FIFO order, par. 0071).

Regarding Claim 11, Martin discloses the system of claim 1, wherein the second component is operative to prioritize update messages according to a determination at the first component (prioritizes predictions based on recent interpretations, thus representing the storage of interpretations in FIFO order, par. 0071).

Regarding Claim 12, Martin discloses the system of claim 1, wherein the processor employs the given owner predictor to determine a predicted owner for a given block of data (predictor 98, par. 0071), the given owner predictor selecting between accessing the first component and the second component according to the frequency in which ownership update messages associated with the block of data have been received from the owner predictor control (an utilization signal indicates if the system is operating under a high utilization, thus indicating high data traffic and thus a high frequency of ownership update messages, or low utilization, see par. 0057). By using the utilization signal, the system of Martin switches between a snooping cache coherence protocol and a directory cache coherence protocol. During a snooping protocol, the request is snooped only to selected processors based on a prediction, thus indicating the use of the claimed first component (see par. 0029). During a directory based protocol, the request is sent to the directory 21 which multicasts the request to appropriate processors indicated by the directory's information (see par. 0051). Depending on the result of the request, the directory must be updated, thus indicating the storage of updated ownership information (par. 0061). Additionally, since the predictor must maintain accurate information about the behavior of spatially adjacent blocks in order to properly make predictions (see par. 0071), the predictor's storage unit must be maintained even when the directory protocol is being followed by storing information about the behavior of the blocks whose ownership was updated using the directory protocol. Otherwise, the predictor may not have accurate information to use in order to formulate its predictions of ownership.

Claim 13 is rejected using the same rationale as Claim 1 wherein Martin discloses a multi-processor network comprising (Fig. 1):

a first processor (12) that includes a cache having a plurality of cache lines associated with respective blocks of data, one cache line in the cache of the first processor transitioning to an ownership state based on a response to a request provided by the first processor (cache 22, par. 0045);

a second processor that includes an associated owner predictor (processor with predictor, Fig. 8 and par. 0043 & 0071);

wherein the owner predictor control (represented by cache controller 26, see par. 0071) broadcasts an update message to respectively owner predictor associate with each of a plurality of processors comprising the multiprocessor network (cache coherence messages are broadcasted over the ordered request network to each of the remaining processor units, see par. 0050)

Claim 17 is rejected using the same rationale as Claim 6 wherein Martin discloses updating the directory (par. 0062).

Claim 18 is rejected using the same rationale as that of Claim 3.

Claim 19 is rejected using the same rationale as that of Claim 8.

Regarding Claim 20, Martin discloses the network of claim 17, further comprising an unordered network interconnect (par. 0049) that enables communication of requests, responses, and update messages among at least the first processor, the second processor and the home node (as shown in Fig. 1 and 8; par. 0044-46).

Claim 21 is rejected using the same rationale as that of Claims 1-3 wherein the owner predictor control (represented by cache controller 26, see par. 0071) provides an ownership update message to an owner predictor associated with each of a plurality of processors (cache coherence messages are broadcasted over the ordered request network to each of the remaining processor units, see par. 0050).

Claim 22 is rejected using the same rationale as that of Claims 4.

Claim 23 is rejected using the same rationale as that of Claims 5.

Claim 26 is rejected using the same rationale as that of Claim 8.

Regarding Claim 27, Martin discloses the system of claim 26, wherein the owner node provides a victim message to the home node and the data response to the requesting node in response to the third request arriving at the owner node prior to the second request, the home node providing a speculation acknowledgement to the requesting node in response to the victim message from the owner node (par. 0051).

Regarding Claim 28, Martin discloses the system of claim 26, wherein the owner node provides a victim message to the home node in response to the second request arriving at the owner node prior to the third request, the owner node also providing the data response to the requesting node in response to the second request from the requesting node (par. 0051).

Regarding Claim 29, Martin discloses the system of claim 21, wherein the at least one predicted node further comprises a target node having a cache that includes the data having one of an invalid state and a shared state (shared state, par. 0046), the at least one predicted node providing a miss response (mispredictions, par. 0062-0064) to the requesting node in response to the second request, and the owner node providing a data response to the requesting node in response to the third request (erroneous predictions, par. 0031).

Claim 30 is rejected using the same rationale as that of Claim 21 wherein the owner predictor control (represented by cache controller 26, see par. 0071) broadcasts an update message to respectively owner predictor associate with each of a plurality of processors comprising the multiprocessor network (cache coherence messages are broadcasted over the ordered request network to each of the remaining processor units, see par. 0050).

Claim 31 is rejected using the same rationale as that of Claims 3-4.

Claim 32 is rejected using the same rationale as that of Claim 5.

Claim 33 is rejected using the same rationale as that of Claim 12.

Claim 34 is rejected using the same rationale as that of Claim 1 wherein the owner predictor control (represented by cache controller 26, see par. 0071) broadcasts an update message to respectively owner predictor associate with each of a plurality of processors comprising the multiprocessor network (cache coherence messages are broadcasted over the ordered request network to each of the remaining processor units, see par. 0050).

Claim 35 is rejected using the same rationale as that of Claims 3-4.

Claim 36 is rejected using the same rationale as that of Claim 5.

Claims 37-38 are rejected using the same rationale as that of Claim 8.

Regarding Claim 39, Martin discloses the system of claim 1, wherein the owner predictor control is configured to discontinue providing the ownership update message corresponding to a given block of data based on (i) an available bandwidth in the

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system (communicating messages based on bandwidth, par. 0002), and (ii) a frequency with which the given block of data changes ownership. A utilization signal indicates if the system is operating under a high utilization, thus indicating high data traffic and thus a high frequency of ownership update messages, or low utilization, see par. 0057. By using the utilization signal, the system of Martin switches between a snooping cache coherence protocol and a directory cache coherence protocol. During a snooping protocol, the request is snooped only to selected processors based on a prediction, thus indicating the use of the predictor control for providing ownership update messages, see par. 0029. If the utilization signal indicates that the snooping protocol must be stopped and the system must use the directory protocol (see par. 0057 wherein a directory mechanism is used when the utilization signal is above a threshold), then this indicates that the predictor control must stop providing the ownership update messages since these messages will be handled by the directory protocol mechanism.

Regarding Claim 40, Martin discloses the system of claim 1, wherein the owner predictor control is programmed to broadcast the ownership update message each of the plurality of owner predictors to indicate the change in the ownership state of the block of data (broadcasting, par. 0005).

Claim 41 is rejected using the same rationale as that of Claim 39.

Allowable Subject Matter

4. Claims 16 and 24 are allowed.

Regarding Claim 16, the Prior Art of record does not teach nor suggest the network and owner predictor as claimed in combination with providing update messages to predict an owner based on the available bandwidth relative to a threshold value.

Regarding Claim 24, the Prior Art of record does not teach nor suggest the system and owner predictor as claimed in combination with the claimed forward and request channels.

Conclusion

5. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MIDYS ROJAS whose telephone number is (571)272-4207. The examiner can normally be reached on M-TH 6:00am - 4:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Sanjiv Shah can be reached on (571) 272-4098. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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